CONSOLIDATION COAL COMPANY MINE No. 11, AEROVANE FAN
East side of State Route 936
Midlothian Vicinity
Allegany County
Maryland

HAER No. MD-87-B

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

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HISTORIC AMERICAN ENGINEERING RECORD

CONSOLIDATION COAL COMPANY MINE No. 11, Aerovane Fan

HAER No. MD-87-B

Location: East side of State Route 936, approximately 0.1 mile south of Interstate 68
Midlothian vicinity, Allegany County, Maryland
UTM: 17.676290.4388805
Quad: Frostburg, Md.-Pa., 1:24,000

Dates of Construction: 1940

Present Owner: Allegany Coal and Land Company
P.O. Box 410
Depot Road
Frostburg, Maryland 21532

Present Use: Vacant (ruin)

Significance: The aerovane fan illustrates the evolution of mine ventilation in the United States during the first half of the twentieth century. It is an example of an axial flow fan. These fans generally replaced centrifugal fans for mine ventilation because of their smaller size and their ability to produce high air pressure at slower speeds. These improvements enabled these fans to provide improved mine ventilation and improve health and safety of mine workers. This aerovane fan, typical of mine ventilation fan designs of its period, was patented by Theodor L. Troller.

Project Information: The U.S. Soil Conservation Service (SCS) has been contracted by the Allegany Coal and Land Company to reclaim the site of the Consolidation Coal Company Mine No. 11. This reclamation project will include removal of existing structures on the site and revegetation of disturbed areas. Reclamation is scheduled to begin in late 1993.

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CONTEXT

The aerovane fan is located at the northeast side of a group of intact site features, approximately 350 feet east of State Route 936. The mouth of the blower of the fan adjoins the north section of tbe east wall of tbe air/manway shaft. The blower tapers inward to the east and is mounted to a rectangular box at its east end. The rectangular air/manway shaft measures approximately 15 feet east to west and 17 feet north to south. Atop the south coursed ashlar wall of the air/manway shaft is the north foundation wall of the fan house. This fan house historically housed the Lepley ventilator that is situated south of air/manway shaft. Only portions of the foundation walls remain.

South and southeast of the aerovane fan are two large circular, brick shafts which may have been steam shafts for the boiler house that historically occupied that area. Southeast of the aerovane fan are a steel pipe scaffold, whose purpose is unknown, and a smaller cylindrical brick shaft. West of the ventilator is a slight depression containing a marshy stream bed. West of the stream bed is the aerovane fan hood, west of the aerovane fan, two manway shaft doors, southwest of the aerovane fan, and an unidentified fragment of crumpled sheet metal, south of the shaft doors, and southwest of the ventilator. South of tbe aerovane fan and ventilator is a wooded gully. The concrete foundation walls for a water tank are located in this gully.

MINE VENTILATION

Ventilation of mines was necessary for several reasons. A sufficient supply of fresh air had to be provided to permit miners and mine animals to breathe. Explosive and inflammable gases, which, if allowed to accumulate, could accidently ignite and cause injuries to miners and damage to the mine. These gases had to be driven out or diluted. Other gases that are formed by the discbarge of explosives, as well as gases given off by the decay of mine timbers and the oxidation of ores, also bad to be dissipated.[1]

Mines were ventilated in one of five ways: 1) natural ventilation; 2) furnaces; 3) waterfalls; 4) steam jets; and 5) mechanical ventilators.[2] In all of these methods of ventilation two openings into the mine were required.[3] Of these methods, only natural ventilation, furnaces, and mechanical ventilators were used in Maryland coal mines.[4]

Initially, Maryland coal mines were ventilated naturally by an air shaft wbich was sunk into the mine workings a sufficient distance from the mine entrance to result in the flow of air through the mine. This sbaft was covered with a wooden stack.[5] Depending on the air flow, the shaft functioned as an exhaust or intake port. Natural ventilation depends for its action on the difference in weigbt between two columns of air of different densities, the flow being from the heavier to the lighter column. This difference in density is primarily due to a difference in temperature between the two columns.[6] With a constant temperature inside the mine, the direction of tbe air current varied

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[1]W.M. Weigel, *Ventilating Equipment.* Library of Coal Mining and Engineering series (New York: McGraw-Hill Book Company, Inc., 1915), 1.

[2]Ibid.

[3]Ibid., 5.

[4]Donna M. Ware, *Green Glades & Sooty Gob Piles: The Maryland Coal Region's Industrial and Architectural Past* (Crownsville, Maryland: Maryland Historical and Cultural Publications, 1991), 221.

[5]Ibid.

[6]Weigel, *Ventilating Equipment,* 1.

depending on the temperature outside. In winter, the heavier outside air caused an inward flow of air, while in the summer, the heavier inside air caused an outward flow of air.[7]

Underground furnaces and surface furnace stacks were also used to ventilate early Maryland coal mines. James B. Thomas, a mine superintendent for the Consolidation Coal Company, first introduced this ventilation method to the region, probably in the 1840s or 1850s. In this method, brick furnaces witb semicircular arches were constructed at the bottom of mine air shafts.[8] Their operation was based on the same principle as natural ventilation, the difference in temperatures, and, therefore, densities of two air columns.[9] The furnaces drew bad air through the workings and expelled it through a brick or wooden stack, built at the surface.

During the mid-nineteenth century mechanical mine fans were developed in England. This technology was first used in Maryland in 1885. A major impetus for the installation of fans in Maryland mines may have the passage of state laws, beginning in 1876, requiring "a proper system of pure air ventilation to be well circulated...throughout the entire mine."[10] Although the provisions of mine inspection laws were fought by mine owners, and state inspections were lax, most mining companies soon installed fans to improve ventilation.

With mechanical ventilation, an air current was generated by means of a rotating or reciprocating mechanical fan. This fan was driven by a motor operated by steam, air, gas, electricity or water power. Fans were employed to force air through the intake shaft and out through tbe upcast shaft or to exhaust tbe air at the outlet, causing a partial vacuum and setting up an air current from the downcast to the upcast shaft.[11] When fans exhausted air from the mine, the working shaft or drift served as tbe downcast or intake; when fans blew air into the mine, the working sbaft or drift served as the upcast or outlet. This arrangement was necessary so that the shaft occupied by the fan could be sufficiently air-tight to create the proper ventilation.[12]

Ventilators ranged in size from the small centrifugal fans used to ventilate the face of a single drift or tunnel and requiring only three to four borsepower for operation to the large colliery fans, ventilating all the workings of a large coal mine and consuming 300 horsepower or more.[13]

The first mine fan in the Georges Creek Basin of Maryland was installed at the Consolidation Coal Company's Eckhart Mine. This fan, no longer extant, was described in a 1887 mine inspection report as a modified form of the Guibal fan. The Guibal fan was one of the first mecbanical mine fan designs and was characterized by its large diameter and its comparatively few blades.[14] The fan installed in the Eckhart Mine measured 16 feet in diameter

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[7]Ibid., 1-2.

[8]Ware, *Green Glades & Sooty Gob Piles*, 221.

[9]Weigel, *Ventilating Equipment*, 2.

[10]Katherine A. Harvey, *The Best-Dressed Miners: Life and Labor in the Maryland Coal Region, 1835-1910* (Ithaca, New York: Cornell University Press, 1969), 210.

[11]Weigel, *Ventilating Equipment*, 4.

[12]Ibid., 5.

[13]Ibid., 4.

[14]Ibid., 17-18.

and had four foot blades that curved backwards with their convex sides facing the direction of the wheel's motion. This fan worked well. As noted in the report, "It has more than met expectations in accomplishing greater work than designed. It supplies abundance of air to three mines--Eckhart, New Hope, and Allegany."[15]

By the 1890s fans were the accepted means of mine ventilation, and most large mines in the Georges Creek Basin had at least one. Most of the early fans were of the centrifugal type. This type of fan had a horizontal shaft fitted with hubs rigidly attached to it. From these hubs radiated arms or spokes to which blades or vanes were attached. The wheel was usually enclosed in a spiral casing which had an opening in one or both sides at the center and another opening in the circumference. As the fan revolved, air was drawn in through the center opening. It then passed between the blades into the spiral casing and out through an opening in the circumference. If the fan drew air through its central opening from the mine, it was referred to as an exhauster. If it delivered air to the mine through the opening in its circumference, it was referred to as a blower.[16] Most of the centrifugal fans used in the Georges Creek Basin were blowers.[17]

Later fans were primarily of the disc, propeller, or axial flow type.[18] This type of fan was developed in the late nineteenth century but was not widely used in the Maryland coal region until the 1920s.[19] These fans have vanes or blades set obliquely to the plane of rotation as in wind mills or screw propellers for boats. The fan was usually mounted on a horizontal shaft and placed directly in the line of the current of air that it moved. The blades altered the velocity of air, causing a difference in pressure on either side of the wheel. This action resulted in the forced movement of air. Blades of these fans were constructed of sheet steel, the inner ends of which were fastened to a hub on the shaft. The back of each blade was braced near the tip to an extension of the main hub or an extra hub. This bracing was necessary to prevent deflection of the light blades by air pressure. A cast-iron or sheet-steel casing encircled the wheel with sufficient clearance to prevent contact with the surrounding ring. When installed, the airway or mine opening was built up close to the surrounding ring with either brickwork or tongued and grooved lumber. Smaller fans had a direct connection between the motor and the fan shaft. Larger sizes used a shaft driven by belting.[20] These fans were smaller in size than the centrifugal fans and could produce a higher pressure while rotating at slower speeds.

During the 1930s an improved axial flow fan design was developed. These fans, incorporating an airfoil blade, were known as aerovane or aerodyne fans.[21] Surviving in situ axial flow fans in the Georges Creek Basin include the

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[15]As cited in Ware, *Green Glades & Sooty Gob Piles*, 221.

[16]Weigel, *Ventilating Equipment*, 9.

[17]Donna M. Ware and Mark R. Edwards, *Final Report of the Coal Region Historic Sites Survey* (Annapolis, Maryland: Maryland Historic Trust, 1984), 498.

[18]R.T. Artz, *Some Practical Aspects of Coal-Mine Ventilation* (Washington, D.C.: United States Government Printing Office, 1951), 2.

[19]Ware, *Green Glades & Sooty Gob Piles*, 221.

[20]Weigel, *Ventilating Equipment*, 13.

[21]Howard L. Hartman, *Mine Ventilation and Air Conditioning* (New York: Ronald Press Company, 1961), 170.

1940 La-Del Troller fan at Consolidation Coal Company Mine No. 11, the ca. 1940 Jeffrey Manufacturing Company fan at the Ocean Mine Number One Complex,[22] and the fan at the Ayers Coal Company Mine in Barton.[23]

AEROVANE FAN

The propeller-type aerovane fan at Consolidation Coal Company Mine No. 11 was electrically powered and was enclosed by a steel hood. This fan was installed in 1940 to ventilate the narrow passages of the small vein Consolidation Coal Company Mine No. 11. To ventilate narrow passages a high pressure of air was needed, and the aerovane became the most popular design for small mines.

This aerovane fan was manufactured by La-Del Conveyor and Manufacturing Company of New Philadelphia, Obio. The fan, which cost $2,648.00 without a motor, was received in September 1940. In the equipment inventory for the shaft, the fan is described as follows:

> La-Del Troller, high pressure, mine ventilating fan, Model H-96, for blowing service complete with 10 Ft. discharge stack and 4' adapter section with door and adjustable aluminum alloy blades, but without motor and drive.
>
> Air shaft equipped with curved hood complete with explosion door.

Additional costs included $622.21 for installation, $269.34 for a foundation, $127.46 for a motor base and guards, $160.08 for power wiring, and $155.16 for V-belt pulleys with belts and guards.[24] The fan was powered by a 75-horsepower motor, wbicb was already on hand.

The name "Troller" was probably coined in recognition of the contributions of La-Del engineer Theodor H. Troller of Akron, Ohio, wbo patented several improvements on propeller type axial fans in the 1930s and 1940s. These improvements were incorporated into the technology of La-Del's mine ventilation fans. In Patent 2,040,452, issued May 12, 1936, Troller patented his first design for improved fan efficiency. This fan was designed to counteract the tendency for air to move perpendicularly to tbe desired delivery direction due to the sbape of the fan blades. His blade design was intended to address this problem.[25] Althougb Troller's blade design resulted in increased efficiency, the usefulness of these blades was hampered by a tendency to "build up layers of fluid whicb slowed down velocity near the walls of all surfaces past which the fluid flows" and could result in a complete breakdown of the flow pattern.[26] In Patent 2,219,499, filed on June 15, 1938, Troller improved upon his previous patent by designing straightener blades "so constructed as to properly straigbten the flow of fluid and at the same time

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[22]David L. Ames, Bernard L. Herman, Gabrielle M. Lanier, and Rebecca J. Siders, *Ocean Coal Mine Number One Complex: Powerhouse and Ventilation Fan*, Historic American Engineering Record (Newark, Delaware: Center for Historic Arcbitecture and Engineering, University of Delaware, 1989), 10.

[23]Ware, *Green Glades & Sooty Gob Piles*, 222.

[24]Allegany Coal and Land Company records concerning Consolidation Coal Company Mine No. 11, Frostburg, Maryland.

[25]Theodor H. Troller, *Fan Construction*, Patent No. 2,040,452, May 12, 1936, 1.

[26]Theodor H. Troller, *Propeller Type Fan Construction*, Patent No. 2,219,499, October 29, 1940, 1.

diverging gradually and uniformly from each other."[27] According to Troller, this design substantially avoided energy losses formerly attributed to the reduction of air velocity.[28]

The fan model shown in the patent drawings (see following figures) was intended as a portable fan, designed to convey air from a main ventilated tunnel a long distance to a room at the working face. However, aside from the use of an internal motor in the patent design, the basic design is similar to that of the Troller aerovane fan at Consolidation Coal Company Mine No. 11.

The hub (9) of the propeller had at its entrance end a rounded nose (10). A motor shaft was attached to the center of the interior of the nose (11) and was driven by a motor (12) whicb was mounted within tbe inner fairing (13). Radially extending propeller blades (14) were secured to or integral with the hub. Four of these blades are shown in the drawings. The inner fairing (13) was coaxial with the outer fairing (7) and was supported by a series of circumferentially arranged vanes (15). According to Troller, these vanes were to be located behind the blades (14) and were secured at their inner ends to the inner fairing (13) and at their outer ends to the outer fairing (7). Electrical conductors, supplying current to the motor (12), could be passed through suitable openings in the blades (15).

The entrance or upstream end of the inner fairing was designed to be cylindrical and conform in diameter to the hub (9). The delivery end of the fairing (16) could be tapered down to a point in order to present a minimum of resistance to the air flow. According to Troller, the entrance end of the outer fairing was preferably outwardly flanged (18), and the portion of tbe outer fairing which surrounded the propeller blades (14) was cylindrical (19) and of sufficient diameter to provide a slight clearance between the inner surface and the outer end of the blades (14).

Troller indicated that the portion (20) of the outer fairing which surrounded the vanes (15) and to which the outer ends of the vanes was secured could be, and preferably was, tapered inwardly from the upstream ends to the downstream ends of the vanes to form a conical section, extending throughout the lengtb of the vanes. From the downstream end of the fairing to the delivery end of the outer fairing, the outer fairing was preferably cylindrical (21). [29]

In explaining the designs of the fan vanes, Troller wrote,

> I have found that by gradually and substantially uniformly increasing the distance between the surfaces of adjacent vanes measured perpendicular or normal to tbe direction of the air flow there between, the desired axial movement of the air stream at the delivery end of the vanes is obtained with a minimum of energy losses connected with the reduction in velocity of the air stream in passing through the vanes.[30]

The Consolidation Coal Company Mine No. 11 aerovane fan consists of two sections. Located at the east end is a rectangular fan housing that measures approximately 10 feet 1 inch from north to south and 11 feet from east to west. It measures 7 feet 10 inches in height. Set into the north wall of the fan housing is a metal door, measuring 25 inches width and 5 feet 1 1/4 incbes in heigbt. Attacbed to the west wall of the housing is a flaring, open-ended, cylindrical blower, constructed of metal and joined with bolted flanges into a series of segments of varying width.

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[27]Ibid.

[28]Ibid.

[29]Ibid., 2.

[30]Ibid.

The blower measures approximately 22 feet 4 and 1/2 inches in length. The metal frame for a small door is in place on the north wall of the blower. Supporting the west end of the blower is a concrete mount.

The mouth of the blower is set within a square steel sheet, measuring approximately 8 feet across. The mouth itself measures approximately 7 feet 6 inches across. Attached to the steel sheet and protruding into the blower mouth are three steel clips. These clips, oriented perpendicularly to one another, were apparently part of a set of four used to attach the fan hood to the fan. Mounted at the rear of the blower is the fan. This fan consists of six, equally spaced blades.

AEROVANE FAN HOOD

Originally, this hood was attached to the west side of the aerovane fan and covered the northern portion of the air/manway shaft opening.[31] The hood is presently separated from the fan and lies approximately 100 feet west of it. The hood has a rectangular footprint, measuring 13 feet 7 inches in length and 8 feet 7 and 1/2 inches in width. The mouth of the hood measures 9 feet 8 inches in height. The top of the hood curves downward from the mouth opening and meets the bottom of the hood at its rear. The walls of the hood are constructed of 1/4 inch steel plate. Tbe hood is given rigidity through use of steel tie bars, extending from one side wall to the other near the mouth and approximately halfway to the back of the hood. The interior contains three curved steel plates bolted to the sides of the hood. These plates are situated approximately 28 inches apart. Each side of the hood consists of seven steel plates, bolted together at L-shaped steel bars. Each bar measures 3/8 inch in thickness.

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[31]Donna M. Ware, *Green Glades & Sooty Gob Piles: The Maryland Coal Region's Industrial and Architectural Past* (Crownsville, Maryland: Maryland Historical and Cultural Publications, 1991), 258.

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